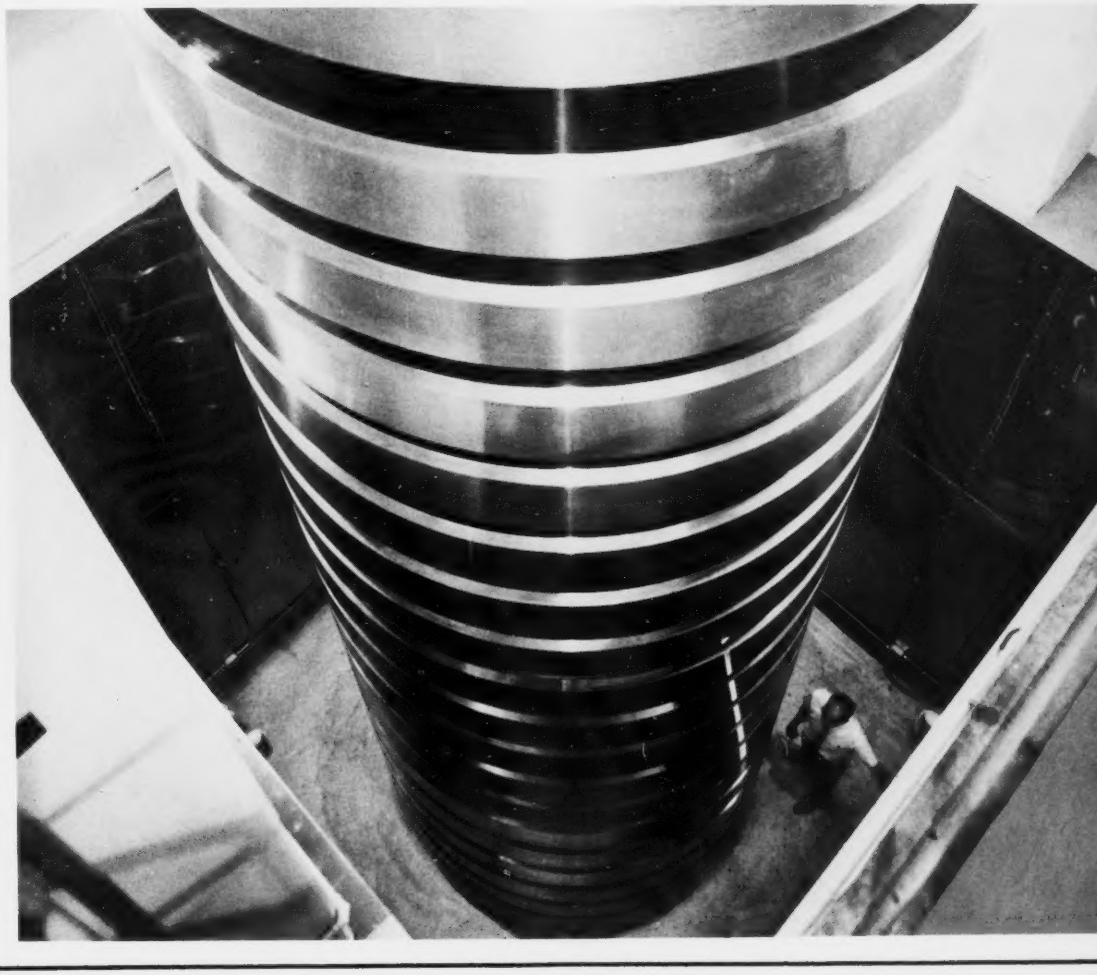
NATIONAL BUREAU OF STANDARDS November 1965

Technical News Bulletin



U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

Technical News Bulletin

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U.S. DEPARTMENT OF COMMERCE
John T. Connor, Secretary

NATIONAL BUREAU OF STANDARDS
A. V. Astin, Director

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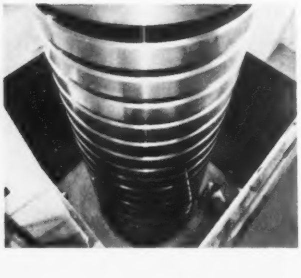

Deadweight stack of the new 1,000,000-lb deadweight machine recently installed at NBS. This machine has greatly enhanced NBS capability for precise calibration of large force-measuring devices such as those used to measure rocket thrusts in the space effort. The weights, each 50,000 lb, are 10 feet in diameter. Most of the stack is below first floor level in a 26-foot pit.

The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized into three institutes—
- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of all three institutes.

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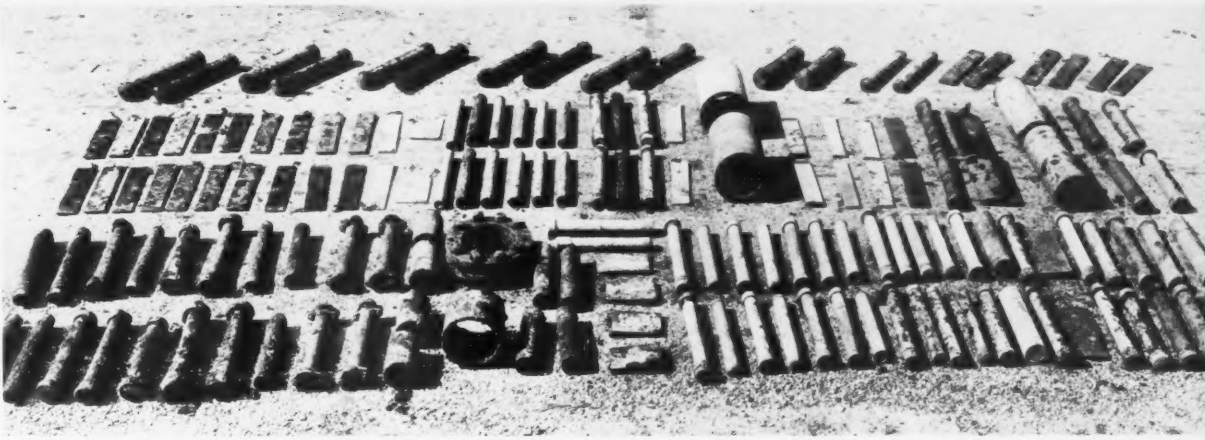


Guidelines Devised for Corrosion Protection

Ferrous Pipelines Studied

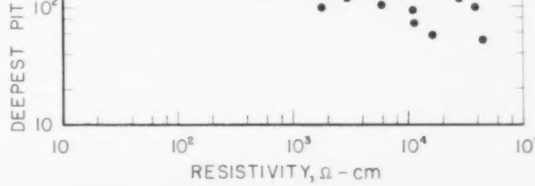
■ Externally applied currents have long been used to protect ferrous pipelines from underground corrosion. The amounts of protective current required, however, vary considerably from one installation to another. Ideally, these amounts would equal the corrosion currents measured on underground pipelines, but in practice this is not the case.

The NBS Institute for Materials Research therefore undertook a study to devise engineering guidelines for estimating total protective current requirements.[1] In this work, W. J. Schwerdtfeger of the Institute's corrosion laboratory analyzed corrosion data obtained on 4500 ferrous specimens that had been installed at 86 different soil test sites for periods up to 17 years.[2] The analysis did not reveal a precise relation between the varying resistivities of the soils and the corrosion currents found for the specimens, but a general relation was observed.

Recent experimental findings on applied currents required to protect steel specimens in underground environments[3] were then applied to the results of the analysis. As a consequence, it was possible to estimate protective factors for three ranges of soil resistivity: (1) 50 to 5000 Ωcm; (2) 5000 to 10,000 Ωcm; and (3) over 10,000 Ωcm. The current required for protection may be obtained by multiplying the measured corrosion currents (after a two-year pipeline

Above: *Specimens upon removal from the Loch Raven, Md., site after installation for periods up to 14 years.*

Extrapolated NBS data on maximum corrosion pit depths that would occur in ferrous specimens during a 30-year exposure period in soils of varying resistivities. These data indicate that a standard length of 8 in. diameter pipe having a wall thickness of 0.322 in. would probably perforate in most soils having resistivities below 1000 Ωcm on exposures of 30 years. In soils having resistivities above 2000 Ωcm, however, the data show that perforations are less likely to occur.



PROJECTED TO AREA OF 45 ft^2 (20 FT-8 in. PIPE)

Four test sites illustrative of the varying environments in which ferrous specimens were installed for periods up to 17 years. Upper, left to right, Lake Charles clay at El Vista, Texas; Merced Silt loam at Buttonwillow, Calif. Lower, left to right, tidal marsh at Charleston, S.C.; Hagerstown loam at Loch Raven, Md.

stabilization period) by a factor of 1.5 in the first range; by a factor of 2.0 in the second range; and by a factor of 3.0 in the third range.

During the course of the present study, the maximum corrosion pit depths found on the 4500 specimens were converted to the maximum depths that would be expected to occur on a standard length of bare 8 in.-diameter wrought ferrous pipe under the same environmental conditions. From these data, it can be predicted that similar pipe having a wall thickness of 0.322 in. will perforate in most soils having resistivities below 500 Ωcm on 15 years of exposure. In the majority of soils with resistivities up to 1000 Ωcm, many perforations would occur on 30 years of exposure. The data also show that in most soils with resistivities over 2000 Ωcm, perforations are less likely to occur during 30 years of exposure; however where hazards or difficult maintenance problems are involved, protective measures such as coatings, protective currents, or both are recommended.

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[1] *For further details, see* Soil resistivity as related to underground corrosion and cathodic protection, *by W. J. Schwerdtfeger, J. Research NBS* **69C** *(Engr. and Instr.), 71 (1965).*

[2] Underground corrosion, *by Melvin Romanoff, NBS Circular 579; also, NBS Tech. News Bull.* **42**, *181 (1958).*

[3] A study by polarization techniques of the corrosion rates of aluminum and steel underground for 16 months, *by W. J. Schwerdtfeger, J. Research NBS* **65C**, *271 (1961), and* Corrosion rates measured electrically in an underground environment, *NBS Tech. News Bull.* **46**, *25 (1962)*; Current and potential relations for the cathodic protection of steel in a high resistivity environment, *J. Research NBS* **63C**, *37 (1959), and* Cathodic protection of steel in a high-resistivity environment, *NBS Tech. News Bull.* **44**, *56 (1960).*

CRPL transferred to ESSA

■ On October 11, 1965, the Bureau's Central Radio Propagation Laboratory was transferred to the Environmental Science Services Administration and renamed the Institute for Telecommunication Sciences and Aeronomy. This is the final step of President Johnson's Reorganization Plan No. 2 of 1965 in which he proposed the consolidation of the Coast and Geodetic Survey, the Weather Bureau, and the Central Radio Propagation Laboratory to form the Environmental Science Services Administration in the U.S. Department of Commerce. In the words of the President, ESSA would provide "a single national focus to describe, understand, and predict the state of the oceans, the state of the upper and lower atmosphere, and the size and shape of the earth."

Dr. C. Gordon Little, formerly CRPL Director, who will continue as Director of the new Institute, presided over official ceremonies at Boulder on October 13, 1965, in connection with the transfer. Speakers on the program included Dr. J. Herbert Hollomon, Assistant Secretary of Commerce for Science and Technology, Dr. Allen V. Astin, Director of NBS, Dr. Robert M. White, Administrator of ESSA, and Dr. Lloyd V. Berkner, Director of the Southwest Center for Advanced Studies.

IMPROVED OMNITAB

gains wide acceptance

■ Expansion and improvement of the OMNITAB general purpose computer program, which now includes almost 100 subroutines, has made it an even more useful scientific tool than when first announced in 1963.[1] New features, developed by Joseph Hilsenrath and his associates of the NBS Institute for Basic Standards, make it possible to write shorter programs, to incorporate text material along with tabular results in such a way as to produce a finished report, and to utilize any of the fundamental physical constants or atomic masses in a calculation by use of the appropriate OMNITAB word in the program.[2]

OMNITAB is an NBS-developed computer program that permits scientists and others who are unfamiliar with programming to communicate with a 7094 computer using simply written sentence commands. The program can be used for the calculation of tables of functions, for solutions of nonlinear equations, for curve fitting, and for statistical and numerical analysis of tabular data. Because of the ease with which certain experimental data may be directly adapted to the OMNITAB input for processing, the OMNITAB program is gaining wide acceptance in both university and governmental laboratories.

Some of the new commands which have been added to the program and which make it possible to write even more concise programs than before are: MOLWT, which computes the molecular weight of any molecule from the empirical formula; CTOF, which converts a column of temperatures from degrees Celsius to degrees Fahrenheit; and FTOC, which converts Fahrenheit to Celsius. Other single-sentence operators compute the translational partition function for a given atomic weight and list of temperatures, and the electronic partition function at a given temperature for a set of energy levels or for a set of temperatures at a fixed energy level.

For convenience, the current best values for the fundamental physical constants and atomic masses of the elements have been incorporated in the program so that by use of the appropriate OMNITAB word, the proper number will be used. A typical one-sentence command employing this feature would be:

MULTIPLY COLUMN 2 BY *PLANCK* STORE IN COLUMN 4

Thus all users obtain the current accepted values for the constants. More accurate values can be substituted in the program as they become available.

New commands which permit format flexibility now make it possible to produce a finished report on OMNITAB. Text material may be incorporated interchangeably with computed results; the command NOTE and certain synonyms enable the program to differentiate between OMNITAB instructions and bibliographic or editorial comment.

The inclusion of a complete set of instructions for matrix operations has greatly expanded the range of problems which OMNITAB handles. Furthermore, these instructions contribute brevity by providing, in addition to compact matrix operators such as INVERT, others which can operate on entire rectangular arrays of numbers at a time. For example, the following instructions are all that are needed to evaluate the 22 expressions in table 1.

ARAISE (B) IN ROW 1 COL 21, R=101, C=10 TO A IN 1, 1 START STORING IN 1, 21

PRODUCTS OF COLS 20 THROUGH 30, STORE IN COL 20

COALSCE ON THE FIRST COL, THE MATRIX IN 1, 19, R=101, C=2, STORE IN 1, 32

In this example matrix (A), 10×101, contains the exponents of the ten variables (a, b, ... j) for each term of each expression. Missing variables of course have zero exponents so that the row in (A) representing the term $(-4)ad$ from expression 5 is written 1,0,0,1,0,0,0,0,0,0.

Matrix (B), 10×101 is formed by duplicating a row of numerical values for a, b, ... j 100 times. The ARAISE instruction raises every element in (B) to the power of the corresponding element in (A); results are stored over "old" (B). Next, the product is taken of eleven columns (column 20 contains the co-

TABLE 1

1. $2a+a^2$
2. $2b+b^2$
3. $2b+a^2+2b^2-2ab$
4. $2c+.5a^2+1.5c^2-ac$
5. $-2a+4d+a^2+4d^2-4ad$
6. $-a+2e+f+.5a^2+2e^2+.5f^2-2ae$
7. $2c+2b^2+3c^2-4bc$
8. $2d+b^2+2d^2-2bd$
9. $-2b+4e+2b^2+4e^2+f^2-4be-2bf$
10. $-b+2g+h+b^2+2g^2+h^2-2bg-bh$
11. $-2b+4i+b^2+4i^2-4bi$
12. $2e+1.5c^2+2e^2+.5f^2-2ce-cf$
13. $-2c+4g+3c^2+4g^2+2h^2-4cg-4ch$
14. $-2c+1.5c^2$
15. $2f+4d^2+4e^2+f^2-8de$
16. $2h+2d^2+2g^2+h^2-4dg$
17. $-4d+6j+4d^2+9j^2-12dj$
18. $-2d+2d^2$
19. $2f+f^2$
20. $4e-2f+4e^2+f^2-4ef$
21. $2h+4e^2+f^2+4g^2+2h^2+8eg-2fh$
22. $-f+2e^2+.5f^2$

(*Continued on p. 191*)

Alpha Particle Backscattering

A measurement of the energy and angular distribution of alpha particles backscattered from metallic source mounts has been made [1] by D. H. Walker of the NBS Institute for Basic Standards. This measurement has led to a method of determining the true disintegration rate of alpha-particle sources in a way which is free from large errors due to backscattered radiation. The work was carried out as part of the NBS program of absolute standardization of radioactive materials, and was performed, in part, to fulfill the constant need for reducing the sources of error associated with the calibration of radioactive nuclides.

In the method of calibration presently used at NBS, alpha-particle counting involves: (a) deposition of an alpha-particle source on a suitable backing and (b) counting of the radiation emitted into a 2π (hemispherical) geometry by means of a proportional counter.[2] Backscattering occurs when alpha particles which are emitted into the backing are scattered back into the proportional counter because of interaction with the backing material. The major source of error in the present method of calibrating solid point sources arises from the uncertainty in the number of backscattered alpha particles.

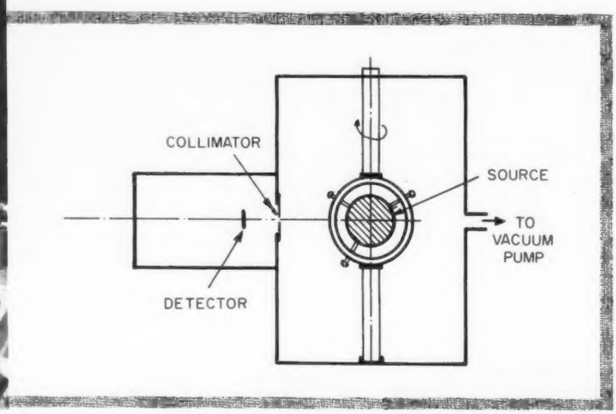
The classical theory predicts a dependence of alpha-particle backscattering on atomic number and since the NBS sources are deposited on two very different backing materials, it was necessary to examine the backscattering from both backings.

For the measurement a counting chamber was constructed which had a rotatable source holder and a carefully placed stationary 5×5 mm semiconducting alpha-particle detector. A collimator in the form of a 0.040-in. hole drilled in a 0.006-in. sheet of aluminum was used to give precise angular definition to the detected alpha particles. Counting rates were measured as a function of angle from grazing incidence to grazing incidence in steps of 1° for alpha particles from polonium-210 deposited on highly polished surfaces of monel metal (Z=29) and platinum (Z=78).

The total backscattering thus found was 2.1 percent for monel, and 3.1 percent for platinum. The intensity of the backscattering alpha particles was found to be large at grazing angles and small elsewhere as shown in the graph on the left. This information indicated that an alpha-particle counter with an acceptance angle of 150° or less whose geometry is accurately known can be

(Continued on bottom of next page)

Left: D. H. Walker places the mounted source in the source holder of the backscattering chamber. Below: Backscattering chamber used to determine the angular and energy distribution of backscattered alpha particles. The source can be rotated with respect to the detector, thus allowing a determination of the counting rate as a function of angle.



Ream heads new Center for Computer Sciences and Technology

■ Secretary of Commerce John T. Connor recently announced the Bureau's appointment of Norman J. Ream of California as Director of a newly-established Center for Computer Sciences and Technology in the Bureau.

Mr. Ream has been Director of Systems Planning for Lockheed Aircraft Corporation, Burbank, California, since 1953.

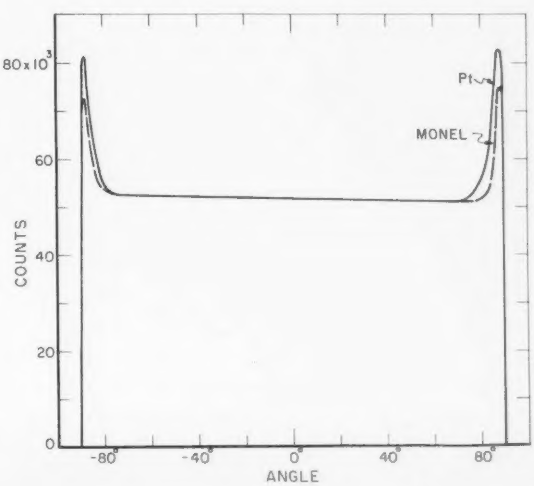
The NBS center will aid Government agencies in achieving greater value for the public's dollar in the selection, acquisition, and utilization of automatic data processing equipment. It will also:

1. Provide advisory and consulting services to Government branches in developing computer systems.
2. Conduct research on computer sciences and information systems design.
3. Guide an executive branch program to develop, measure, and test voluntary computer standards.
4. Recommend uniform standards for automatic data processing equipment, techniques, and languages for equipment and services procured by the Federal Government.

The new center will combine the Information Technology Division of the NBS Institute for Applied Technology with the computation section of the Applied Mathematics Division of the NBS Institute for Basic Standards.

Mr. Ream began his new duties October 1. Before joining Lockheed, he was Assistant to the Treasurer of Lever Brothers Co. from 1950 to 1953 and Director of Accounting Research for International Business Machines from 1947 to 1950.

S. N. Alexander, former Chief of the NBS Information Technology Division, has been named Technical Director and deputy head of the new Computer Science and Technology Center, to be located at NBS's Institute for Applied Technology.



Counting rate of a polonium-210 alpha-particle source as a function of angle. Extra counts are only present at angles less than 15° from the source backing. The dotted line represents the isotropic alpha-particle distribution to be expected for the condition of no backscattering.

used to obtain accurate and direct calibrations of alpha-particle sources without the need of correcting for counts due to backscattering. Such a detector is presently being constructed and will be in operation in the near future.

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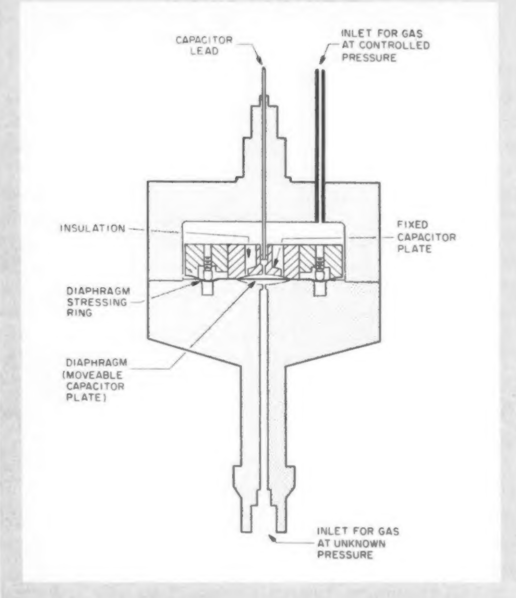
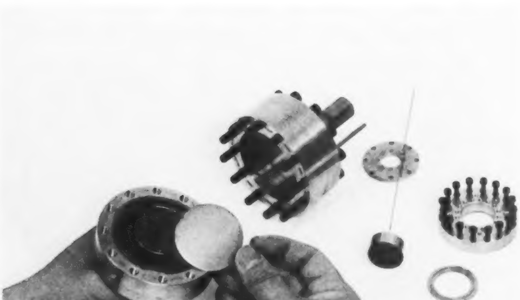
[1] *For further technical details, see* An experimental study of the backscattering of 5.3-MeV alpha particles from platinum and monel metal, *by D. H. Walker, Int. J. Appl. Rad. Isotopes,* **16,** *183 (1965).*

[2] *Ideally, mounting the source on an extremely thin film of low atomic weight and counting in a 4π (spherical) geometry is preferable, but experience has shown that thin backings often yield unstable sources.*

Transducer Allows Accurate Measurement of Corrosive Gas Pressures



Diaphragm of a pressure transducer separates two pressure systems, one connected to the sample and the other to a laboratory-controlled pressure system.



Null-type pressure transducer consists essentially of two half-housings, to one of which (bottom) *a 0.001-inch-thick diaphragm is clamped by a ring* (right) *encircling an insulated capacitor plate (with stem).*

■ A pressure transducer developed at the NBS Institute for Basic Standards enables the scientist to measure accurately the pressure of corrosive gases over wide temperature and pressure ranges.[1] The device was designed by Meyer Waxman and William Chen, of the Institute's staff, in research supported in part by the Atomic Energy Commission.

The instrument is essentially a means of comparing an unknown pressure with a known pressure. It uses a null indication to determine when the pressures in two separate systems are the same; associated errors in sample volume are virtually eliminated through the use of this instrument. The null is identified by a simple capacitive system which contributes negligible error.

The transducer was developed for a Bureau study of the compressibility of corrosive gases. This study required measurements of pressures as high as 250 atmospheres at temperatures from 0 to 175 °C. Transducers in which a diaphragm separates the sample gas from an auxiliary pressure system appeared most promising; such transducers have been developed at the Bureau in the past.[2] In application with the sample volume connected to a chamber on one side of the transducer, the auxiliary gas pressure is adjusted to return the diaphragm to its null position. The sample pressure is then found by measuring the controlled pressure.

The pressure, temperature, and corrosion-resistance requirements of the compressibility application far exceeded the capabilities of existing diaphragm-type transducers. Transducers of sufficient sensitivity were not satisfactory because the diaphragm when subjected to a large pressure imbalance was distended beyond its limit of elasticity and failed to return to null position. Messrs. Waxman and Chen overcame this difficulty by stretching the diaphragm tight, like a drumhead, and by limiting its movements in either direction by use of backing plates shaped to support the diaphragm. This design confines diaphragm movements within elastic limits and isolates the sample gas from laboratory equipment; it also insures that the sample volume will be essentially constant.

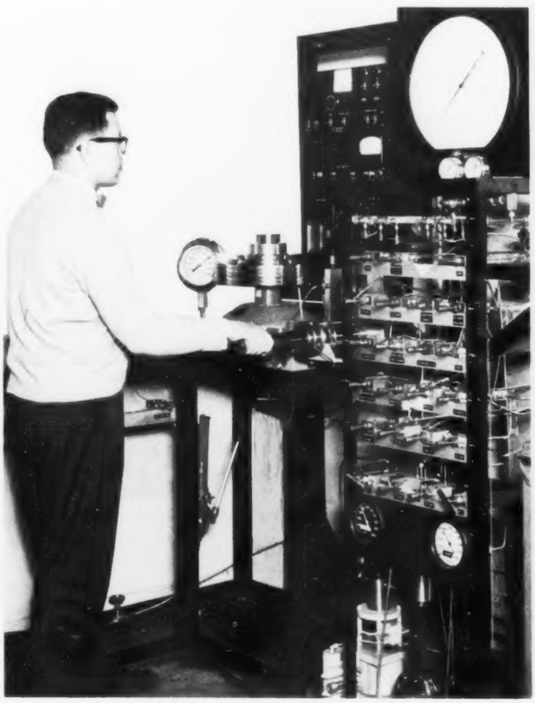
(*Continued on bottom of next page*)

NSRDS adds Radiation Chemistry Data Center

■ As part of the National Standard Reference Data System (NSRDS), a radiation chemistry data center has been set up at the University of Notre Dame, Notre Dame, Ind. Jointly sponsored by NBS and the Atomic Energy Commission, the new facility will compile and evaluate data on chemical reactions brought about by ionizing radiations—for example, alpha, beta, and gamma radiations. In addition, the facility will serve as an international focal point for the collection, storage, evaluation, and dissemination of radiation chemistry data. All information will be evaluated by scientists now working in the field of radiation chemistry throughout the world.

The center is under the direction of Prof. Milton Burton, director of the University's radiation laboratory, and it is located in the radiation research building built on the campus by the Atomic Energy Commission in 1963. Initial efforts will be concerned with the compilation, critical evaluation, and interpretation of available data relating to reactions induced by ionizing radiation. Types of data to be compiled include chemical reaction yields (for instance, in aqueous solutions, hydrocarbon solutions, and crystalline solids), effects on physical properties, and specific rates of elementary processes.

The NSRDS is a government-wide program for promoting and coordinating systematic data compilation and evaluation in all fields of the physical sciences. This program, administered by the Bureau, was established by the President's Office of Science and Technology in 1963.



William T. Chen varies the pressure of argon gas applied to a transducer for measuring the pressure of corrosive gases. The transducer is contained inside the upright isothermal container at right. The pressure of the argon will equal the sample pressure at the null point, which is indicated by the capacity bridge on the rack in the corner. Applied pressures of 4 to 250 atmospheres are measured by the piston gage, in front of the rack.

Capacitance as a Positional Indicator

The metallic diaphragm and contoured backing plates suggested the use of capacitance to sense diaphragm position. This is done by electrically insulating the central part of one of the backing plates from the rest of the instrument and bringing a lead out from this plate. The capacitance between the insulated backing plate and the diaphragm varies with diaphragm displacement. The null or neutral diaphragm position can be identified for different pressures if the capacity, nominally 49 pF, is known.

The null is identified by means of a stable and sensitive capacity bridge. It consists of the transducer capacity in one arm, a variable capacity in another arm, two large and nearly equal capacitors in the ratio arms, and a resistive-balancing adjustment. Precautions to minimize the effect of variations in stray or unavoidable capacitances on the bridge balance include the use of double-shielded coaxial cable between the transducer and bridge. A pressure imbalance across the diaphragm deflects its and unbalances the bridge. The unbalanced signal is amplified, phase detected, and indicated on a 100–0–100 output meter.

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[1] A rugged null-type pressure transducer of high reproducibility for accurate gas phase PVT measurement, *by Meyer Waxman and William T. Chen, J. Res. NBS* **69C** *(Eng. and Instr.), 27–33 (Jan.–March 1965).*

[2] A highly sensitive differential manometer, *NBS Tech. News Bull.* **32,** *132–33 (Nov. 1948), and* Precision resistance thermometry and fixed points, *by H. F. Stimson, Temperature, Its Measurement and Control in Science and Industry, Vol.* **2,** *141–168 (Reinhold Publishing Corporation, New York, 1955).*

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Mechanism proposed for the SOLVENT EFFECT

■ Chemists at the NBS Institute for Materials Research are investigating the mechanism of the "solvent effect." This is the name given to the change in acid strength when organic solvents are added to acids in aqueous solution—a change that cannot be explained by simple electrostatic theory.

After a series of studies [1,2,3] of the behavior of acids in methyl alcohol-water solvents, R. G. Bates and his associates of the electrochemical analysis laboratory have proposed a possible explanation of the solvent effect. They postulate that the organic solvent added to a water-rich medium breaks down the water, which is normally in a clustered form at room temperature, thereby increasing the basicity of the medium.

Because many chemical processes that occur in solution are essentially interactions between acids and bases, the solvent effect is of considerable interest in the fields of chemistry, pharmaceutics, and medicine. Such processes include the synthesis of many organic chemicals and drugs, as well as enzymatic and related physiological operations of importance for clinical studies and medical research. These operations are often conducted in partially nonaqueous media, either because the reactants are not sufficiently soluble in water, or because a particular nonaqueous solution has a favorable effect upon the reaction rate or the extent of the reaction. Although some of these changes are profound, they are not well understood.

To gain a deeper insight into the course followed by the solvent effect, the NBS scientists are examining the relationships among acid structure, charge type, acid strength, solvent basicity, and the dielectric constant of the solvent.

Using a potentiometer Mrs. Maya Paabo makes emf measurements of an acid dissolved in methanol-water mixtures with a potentiometer.

When the medium in which an uncharged, weak acid is dissolved is altered by the addition of an organic solvent of lower dielectric constant, the strength of the acid decreases. This effect is readily explained by the electrostatic influence of the lowered dielectric constant of the solvent on the process of ion separation.

The behavior of positively charged weak acids is less easily explained. When these acids dissociate in a medium, the number of ions does not change. Hence, electrostatic influences should not affect the ionic equilibrium. Nevertheless, the general pattern of the solvent effect of methyl alcohol on weak acids, such as the ammonium ion and the protonated forms of the common amine bases, is an initial increase of strength when the alcohol is added to a water-rich solvent. This increase continues up to a methanol concentration between 60 and 80 wt percent, where the ionization constant goes through a maximum and then falls rapidly as the water content of the solvent decreases.

In explaining the results of these acid-solvent mixtures, the NBS investigators have examined the electrostatic approach in detail. If the acid ions and the solvent ions are identical in size and contour, the work of charging a mole of each in the same medium should be equal. Thus, a change in the solvent would not influence either the dissociation constant, or the amount of energy absorbed or released when a mole of acid ions dissociates. If the ion sizes are different, different amounts of energy are required to charge the two ions; consequently, the dissociation energy should vary with the solvent. A further refinement is the assumption that the solvent's dielectric constant varies from a minimum near the ion surface to its maximum value at a distance of about 4 Å away from the center of the ion.

Such electrostatic calculations explain some of the increase in cationic acid strength when methyl alcohol is added to the aqueous solvent, but the calculated increase is always far less than that actually observed. The deviations are too large to be attributed to oversimplifications in the calculations. Similar attempts to explain the decreased strengths of uncharged acids also produce calculated strengths lower than those actually observed. The deviations are approximately the same for both types of acid in a solvent of fixed composition. This observation indicates that a "basicity parameter," characteristic of the solvent, should be superimposed upon the electrostatic parameters to explain fully the solvent effect.

(Continued on p. 190)

Standard Materials

Guide for Requesting Preparation of Standards

Requests for NBS to prepare standard reference materials continue to exceed the Bureau's capacity to produce and certify these materials. To determine an order of priority for these requests, the Bureau needs and relies heavily upon information supplied by industry. This information comes from industry's representatives as well as from interested groups such as the American Society for Testing and Materials, the American Standards Association, and the International Organization for Standardization.

To facilitate the flow of this information, NBS has prepared a "Guide for the Submission of Requests for the Development of New or Renewal Standard Reference Materials." This "Guide" will help industry supply the information NBS needs to concentrate its efforts on the most urgently needed standard reference materials.

The "Guide" has been printed on a tearsheet in the rear of NBS Miscellaneous Publication 260, entitled "Catalog and Price List of Standard Reference Materials Issued by the National Bureau of Standards."[1] Individual copies of the "Guide" may be obtained directly from the NBS Office of Standard Reference Materials.

Preparation of Third Beryllium-Copper Standard

In addition to the two beryllium-copper standards being prepared at NBS (reported in this column February 1965), preparation of a third standard urgently needed by the aerospace industries is now under way. Preparation and analytical work on this third standard should be completed within six months. The beryllium-copper standards will be announced in this column as soon as they become available.

New Radioactivity Standard Available

A new point-source gamma-ray radioactivity standard of niobium-94, NBS Standard No. 4201, is now available from the Bureau.[1] The long half life of the radioactive material, approximately 2×10^4 years, makes this standard useful indefinitely. Niobium-94 emits 0.703-MeV and 0.874-MeV gamma rays. This convenient energy spacing provides a means for quick determination of the energy resolution of x-ray detectors. The new standard also contains a niobium-93m impurity, which emits 16-kev x rays that are useful for energy calibration of detectors. No radiations that would impair the usefulness of the standard are associated with this impurity. The approximate activity of this standard as of July 1965 is 1×10^4 dps (disintegrations per second). NBS Standard No. 4201 may be ordered singly under the general licensing provisions of the Atomic Energy Act of 1954; the price of each standard is $55.00.[2]

[1] *For a list of NBS standards, see* Standard Reference Materials: Catalog and Price List of Standard Materials Issued by the National Bureau of Standards, *NBS Misc. Publ. 260, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402, for 45 cents.*

[2] *This standard may be ordered from Julia C. Holland, Radioactivity Standard Samples, Radioactivity Section IBS, National Bureau of Standards, Washington, D.C., 20234. The licensing provisions of the Atomic Energy Act of 1954 are contained in the Federal Register, Vol. 21, p. 213 (Jan. 11, 1956).*

Standards and Calibration—

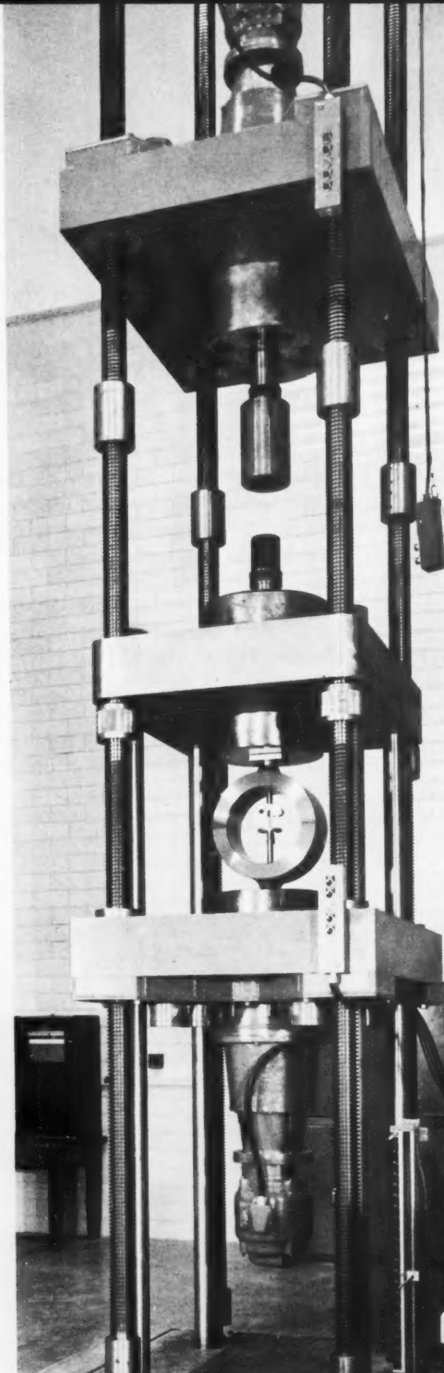
Changes in NBS Radio Broadcasts

In accordance with National Bureau of Standards policy of giving monthly notices regarding changes of phases in seconds pulses, notice is hereby given that there was no change in the phase of seconds pulses emitted from radio station WWVB, Fort Collins, Colorado, on November 1, 1965.

Notice is also hereby given that there was no change in the phase of time pulses emitted from radio station WWV, Greenbelt Maryland, and WWVH, Maui, Hawaii, on November 1, 1965. These pulses at present occur at intervals which are longer than one second by 150 parts in 10^{10}. This is due to the offset maintained in frequency, as coordinated by the Bureau International de l'Heure (BIH).

New NBS Force-

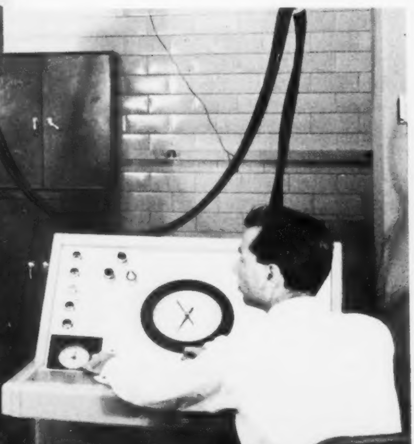
Capacity i



■ New facilities recently placed in operation by the NBS Institute for Basic Standards have greatly enhanced the Institute's capability for precise calibration of large force-measuring devices, such as those used to measure rocket thrusts in the space effort. The new equipment comprises three huge deadweight machines—of 1,000,000-lb, 300,000-lb and 112,000-lb capacities—which have been installed in the NBS Engineering Mechanics Laboratory at Gaithersburg, Md.

These machines apply loads up to a million pounds, in tension or compression, with an uncertainty of 0.002 percent or 20 lb at 1,000,000 lb. Previously, the load limit of the largest NBS deadweight machine was 111,000 lb. The new machines have reduced the time required to calibrate 1,000,000-lb capacity force-meas-

Second-floor level of the 1,000,000-lb capacity deadweight machine. A million-lb capacity proving ring is in position for calibration. By remote control, Arnold J. Mallinger is operating the hydraulic jack (third-floor level) which lifts the weights in the deadweight stack (first-floor level).



Force-Calibration Facilities

…pacity increased to one million pounds

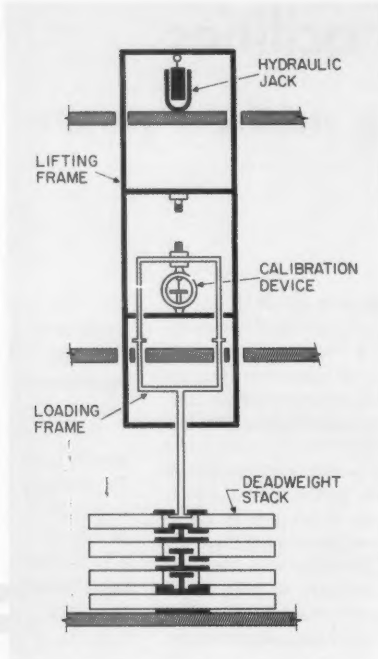
uring devices by almost half and they provide loads with accuracies that are 10 to 50 times as great as were previously possible. It is estimated that the improved accuracy will save the defense and space programs many millions of dollars in the development of rocket engines since fewer thrust-measurement tests will be required.

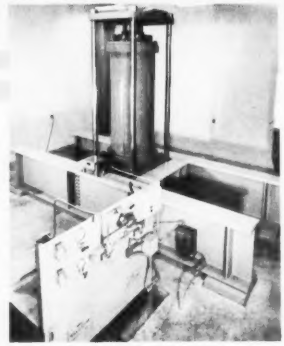
Force measurements also are important in industry for weighing operations, materials testing, and automatic control of machinery. Most of the nearly one-thousand force-measuring devices calibrated at the Bureau each year are calibrated for force-device manufacturers and standards laboratories to serve as reference standards for industry. However, force-measuring devices used in some critical space applications, particularly those of million- and multi-million-lb capacity, are calibrated at the Bureau directly. Just before each Mercury space flight, a set of force-measuring devices was recalibrated at the Bureau for use with the Atlas rocket engine during the launch of the space vehicle.

Deadweight machines are complex vertical equipments consisting of a stack of weights at the bottom, the loading frame to which the top weight in the stack is attached, a lifting frame to which the loading frame is linked by the device to be calibrated, and at the top, a hydraulic jack. As the hydraulic jack raises the lifting frame and in turn the loading frame, the weights in the stack, which are connected together somewhat like links in a chain, are lifted one at a time from the top

Deadweights, ranging from 1,000 lb to 50,000 lb, prior to installation in three large-capacity—1,000,000-lb, 300,000-lb, and 112,000-lb—deadweight machines. The 50,000-lb weights are 10 feet in diameter; the 1,000-lb weights are 3 feet in diameter.

Mr. Mallinger calibrates a million-lb capacity proving ring in the new 1,000,000-lb capacity deadweight machine.





Left: *First-floor level of the 1,000,000-lb capacity deadweight machine. Raymond Russell is cleaning the weights.* Center: *Schematic diagram showing the principle of operation of the large-capacity deadweight machines. As the hydraulic jack raises the lifting frame and in turn the loading frame through the calibration device, the weights, which are connected somewhat like links in a chain, are lifted one at a time from top down. The number of weights picked up depends only on the height to which the loading frame is raised.* Right: *Third-floor level of the 1,000,000-lb deadweight machine recently installed in the NBS Institute for Basic Standards. The hydraulic jack for the million-pound deadweight stack is shown* (above) *with the hydraulic power supply* (lower left).

down. (The number of weights picked up depends only on the height to which the loading frame is raised.) A force-measuring device is calibrated by measuring (electrically or mechanically) the deformation of the device when the deadweight load is applied and comparing this measurement with one taken under no-load conditions.

The overall height of the 1,000,000-lb capacity machine is 96 ft (30 m); that of the 300,000-lb capacity machine, 62 ft (19 m); and that of the 112,000-lb capacity machine, 54 ft (17 m). The Engineering Mechanics Laboratory was designed to house these machines, so that the floors of the force-measurement rooms are at a common level and the roof height varies according to the height of the machines. Each machine has three separate floor levels; the two larger deadweight machines have a portion of their deadweight stacks in pits below the first-floor level.

Temperature is carefully controlled in all the rooms occupied by the deadweight machines to insure maximum transfer of accuracy in calibration. During a calibration, temperatures in the measurement rooms can be held constant within 0.3 degree C at any preselected nominal temperature between 10 and 38 °C. The pits below first-floor level have humidity as well as temperature controls to minimize changes in the mass of the stainless steel weights due to corrosion.

The deadweight stack of the 1,000,000-lb capacity machine has twenty 50,000-lb weights. The 300,000-lb capacity machine has thirteen 10,000-lb weights, four 20,000-lb weights, and three 30,000-lb weights. The 112,000-lb capacity machine has ten 10,000-lb weights, nine 1,000-lb weights, and one 3,000-lb weight. Diameters of the deadweights range from 10 ft (3 m) for the 50,000-lb weights to 3 ft (1 m) for the 1,000-lb weights.

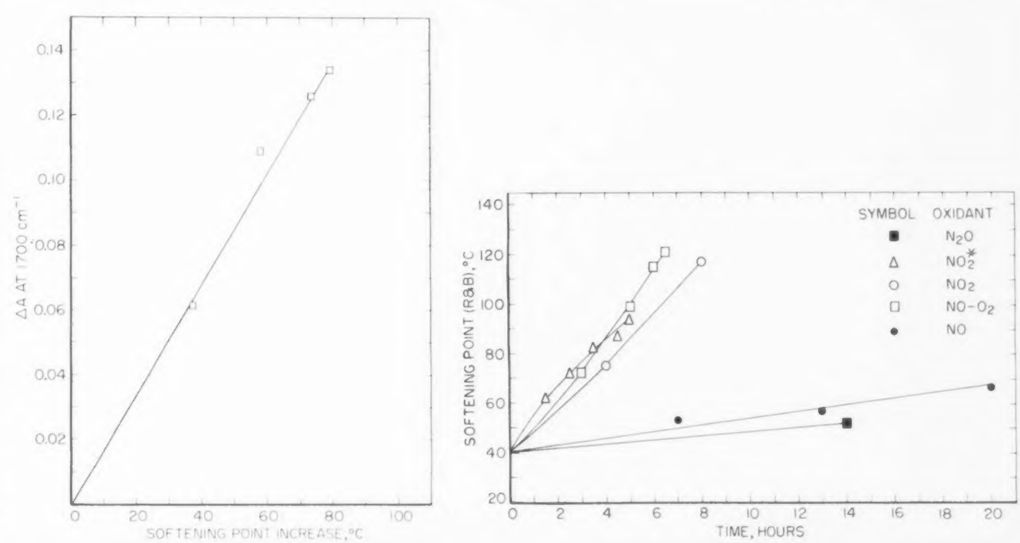
Nitrogen oxides improve asphalt

—*Speed production*
—*Increase hardness*

■ In a recent study at the NBS Institute for Applied Technology, the effects of blowing asphalt with various oxides of nitrogen were investigated. In this study,[1] P. G. Campbell and J. R. Wright replaced air in the blowing process with a mixture of nitrogen and small amounts of nitric oxide, nitrous oxide, nitrogen dioxide, photosensitized nitrogen dioxide, and a mixture of nitric oxide and oxygen, respectively. The results show that treatment of asphalt flux with nitrogen dioxide, photosensitized nitrogen dioxide, and a nitric oxide-oxygen mixture produces coating-grade asphalts much faster than does blowing with air. Moreover, the asphalts thus produced are more stable to photo-oxidation, and to film rupture at any given rate of shear, than are commercial asphalts from the same flux.

The controlled oxidation or "blowing" of asphalt flux has been used for over a century to improve the hardness of asphalt. Such asphalt is used as a roofing material on the majority of residential buildings in the United States today. Methods of improving asphalt quality by modifying the blowing conditions,[2] by replacing air with more reactive oxidants,[3] and by the use of catalysts [4] have been investigated recently at the Bureau. Nitrogen oxides were studied as oxidants because their effects on asphalt are not well understood, even though there are a few references in the patent literature to the use of nitrogen compounds in asphalt blowing.

Left: *The softening point and carbonyl absorbance changes represent, respectively, all of the reactions that cause hardening of the asphalt, and the amount of oxidation that has occurred in the asphalt.* Right: *Southeastern USA asphalt flux was blown to coating-grade hardness using several oxides of nitrogen. Nitrogen dioxide* (NO_2)*, photosensitized nitrogen dioxide* (NO_2*)*, and a mixture of nitric oxide and oxygen produce harder asphalts in less time than do nitric oxide* (NO) *or nitrous oxide* (N_2O).



In the present study, Southeastern USA asphalt flux was blown to coating-grade hardness by use of a gas mixture of 90 percent nitrogen and 10 percent of a nitrogen oxide. The flux temperature varied between 110 and 150 °C and the gas flow was maintained at 250 cm^3 per min. A controlled temperature chamber at 0 °C was used to measure the infrared spectra of the soft asphalts. The method employed to measure photo-oxidation rates, due to carbon-arc irradiation, was based on changes in the infrared spectra of 25-micron films at 1700 cm^{-1} (carbonyl absorbance) for selected times. Viscosity measurements were made on a sliding plate microviscometer at a temperature of 40 °C.

Under mild reaction conditions (temperatures approximately one-half those used in commercial blowing, and minimal gas flow rates) the asphalt hardened in relatively short reaction times with nitric oxide-oxygen, nitrogen dioxide, and photosensitized nitrogen dioxide. Although nitric oxide alone had little effect, when oxygen was mixed with it in the heated flux, the softening point rapidly increased, reaching 121 °C in 6.5 hours. This rate exceeded that caused by either nitrogen dioxide alone (177 °C in 8 hours) or pure oxygen (118 °C in 16.3 hours). Under the same experimental conditions, using air, a softening point of only 58 °C was obtained after 24-hours' blowing time.

Chemical Changes During Blowing

The increase in softening point as a function of reaction time is indicative of complex chemical changes which cause asphalt hardening. Infrared analysis of unsupported asphalt films provides a method for determining the nature of the functional groups formed when an asphalt flux undergoes hardening.

Infrared spectra of the asphalt flux were therefore taken before and after treatment. For example, with photosensitized nitrogen dioxide the spectrum for the treated flux shows decreases in transmittance at 1700 cm^{-1} and in the regions of 1550–1500 and 1350–1300 cm^{-1}, which were not present in the untreated flux. The transmittance decrease at 1700 cm^{-1} is due to the formation of carbonyl groups (aldehydes, ketones and acids), while those in the regions of 1550–1500 cm^{-1} and 1350–1300 cm^{-1} correspond to the asymmetric and symmetric stretching vibrations of covalent nitro compounds. Only insignificant changes were found around 3500 cm^{-1} and in the 2700 cm^{-1} region representing hydroxyl groups.

The presence of nitro groups in the treated asphalt was anticipated. However, the large amount of carbonyl compounds formed, when no free oxygen was used in the blowing process, indicated that some dissociation of nitrogen dioxide must have taken place. Apparently some contribution to hardening came either from the nitrogen dioxide, from a reactive dissociation complex, or from a more reactive form of oxygen.

The softening-point increase for flux treated with nitric oxide-oxygen was plotted versus the carbonyl absorbance changes of the same flux. The resultant curve shows a direct relationship between the two variables. These variables represent, respectively, all of the reactions that cause hardening, and the amount of oxidation that has occurred. This relationship should apply to other asphalts and oxidants. However, asphalts of different origins would be expected to respond differently to oxidation, and various oxidants would be expected to differ in their oxidizing ability.

Effects of Photo-Oxidation

The effects of photo-oxidation (caused by exposure in a carbon-arc weatherometer, at 49 ° C and 40 percent relative humidity) on the rheological properties of thin films of the blown asphalts were investigated. Microviscometer measurements showed that for any given rate of shear, within the range of the experimentally determined values, the viscosities of the photo-oxidized specimens were greater than those of the original samples; the longer the exposure, the greater the viscosity.

[1] *For further information*, see Oxidation of asphalt flux with oxides of nitrogen, *by P. G. Campbell and J. R. Wright, Ind. Eng. Chem. Prod. Res. Dev.* **4**, *No. 2, 121–128 (June 1965)*.

[2] The effects of blowing variables on the durability of coating-grade asphalt, *by S. H. Greenfeld, Ind. Eng. Chem. Prod. Res. Dev.* **3**, *No. 2 (June 1964)*; *also*, Effect of blowing conditions on asphalt durability and blowing time, *NBS Tech. News Bull.* **48**, *No. 6, 94 (June 1964)*.

[3] Ozonation of asphalt flux, *by P.G. Campbell and J. R. Wright, Ind. Eng. Chem. Prod. Res. Dev.* **3**, *No. 3, 186–194 (Sept. 1964)*; *also*, Oxygen and ozone improve asphalt durability, *NBS Tech. News Bull.* **49**, *No. 2, 36–37 (Feb. 1965)*.

[4] Additives improve roofing asphalts, *NBS Tech. News Bull.* **49**, *No. 9, 142–143 (Sept. 1965)*.

Solvent Effect—*Continued*

The unexplained enhancement in strength suggests that, when methyl alcohol is added to water, the basicity of the medium increases, passes through a maximum, and then decreases as the composition approaches pure methyl alcohol. At first thought this observation is surprising, for water molecules are believed to be more basic than methanol molecules. At room temperature, however, a considerable part of the water exists in a clustered structure. If methanol were to cause a breakdown in this clustered structure, an increase in the total basicity of the medium would result. Additional work under way at NBS, as well as studies elsewhere, should shed further light on the validity of this proposed mechanism.

[1] Interpretation of *p*H measurements in alcohol-water solvents, *R. G. Bates, M. Paabo, and R. A. Robinson, J. Phys. Chem.* **67**, *1833 (1963)*.

[2] Medium effects on the dissociation of weak acids in methanol-water solvents, *E. E. Sager, R. A. Robinson, and R. G. Bates, J. Res. NBS* **68A** *(Phys. and Chem.), No. 3, 305 (1964)*.

[3] Acid-base behavior in 50-percent aqueous methanol: Thermodynamics of the dissociation of protonated tris-(hydroxy-methyl) aminomethane and nature of the solvent effect, *M. Woodhead, M. Paabo, R. A. Robinson, and R. G. Bates, J. Res. NBS* **69A** *(Phys. and Chem.), No. 3, 263–270 (May–June 1965)*.

Cooperative Studies on the Problems of Handling Space Fuels

■ A joint program of industry-government research that is closely related to the use of low-temperature fuels for space exploration was announced by the Bureau.

Working with the aerospace industry and with NASA, the NBS Institute for Materials Research has set up cooperative studies that scientists hope will improve performance of systems using low-temperature liquids.

Under an NBS Research Associate program, Aerojet-General Corporation has loaned a specialist in low-temperature liquids to NBS from its research center at Sacramento, California. Dale Nielsen, the Aerojet-General scientist, will work with one of the country's outstanding scientific groups in this field, in the Cryogenics Division at the NBS laboratories in Boulder, Colo.

The NBS team, under B. W. Birmingham, has been engaged for a number of years in studies of fundamental properties of low-temperature fluids, and how they act while flowing and as they are subjected to heat. Because of his experience, Nielsen adds to the team's ability to relate the new findings to ways for reducing the weight and power required by low-temperature pumps. Aerojet-General designed and built the Titan booster power plant engines used in stages one and two of the Gemini launching.

In its research, the NBS team is using TV equipment, high-speed movie cameras, ultrasonic detectors, and small, accurate pressure and temperature gages to record and study foam and bubble formation in low-temperature liquids as they are flowing.

According to Robert L. Stern, Chief of the NBS Office of Industrial Services, the Aerojet-NBS project is part of a new emphasis on joint research, geared to long-term benefits in science and industry.

Under the Research Associate program, scientists and engineers from industry conduct vital research at NBS under sponsorship of their own companies. They work with the precision equipment and the specially trained staff of NBS, towards solutions considered to be significant to industry, and in the national interest. On completion of the research, NBS makes the results available so that they may benefit the entire nation's scientific and technological communities, in and outside government.

A number of Research Associate programs are now under way at NBS, in such other fields as building research, plastics, and lasers.

Improved OMNITAB—*Continued*

efficient of each term); results are stored in column 20. Finally, the terms belonging to the same expression are added together on the basis of an identification number in column 19; expression number and answer are stored in columns 32 and 33 respectively.

The OMNITAB operating procedure, the complete list of commands, and a discussion of the variety of problems for which OMNITAB can be used are available in a user's manual soon to be published as NBS Handbook 101. An abridged version of this manual is already included as a subroutine in the program; the print-out of this abridged version may be called for by use of the word MANUAL. Similarly, the OMNITAB instruction set can be called for by use of the word, COMMANDS. As additional instructions are added to supplement the manual and keep it up to date, they may be called for by use of the word, WATSNU.

The repertoire of OMNITAB operations and subroutines exceeds that which can be stored at one time in a 32 K (about 32,000 storage locations) machine. Consequently, the subroutines have been arranged in a compatible system operating under the IBSYS monitor.[3] Under this system, which was designed at the University of Maryland Computer Science Center, frequently used parts of the program are always in the core and less used portions are read into the core as needed from system tape.

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[1] OMNITAB: A second generation general purpose computer program, *NBS Tech. News Bull.* **47** *(Jan. 1963)*.

[2] *For further details, see* A general-purpose interpretive program for the calculation of tables of functions and statistical and numerical analysis, *by Joseph Hilsenrath, Guy G. Ziegler, Carla G. Messina, Philip J. Walsh, and Robert J. Herbold, NBS Handbook 101 (1965) (to be published)*.

[3] *International Business Machines Corporation System monitor.*

PUBLICATION *Briefs*

NOTE: Publications mentioned in this column, unless other wise stated, are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. NSRDS-NBS 3, Sec. 1, $0.35; Handb. 99, $0.35; Misc. Publ. 267, $2.00; NBS J. Res., Sec. D, $1.00.

Selected Tables of Atomic Spectra, Section 1

The increasing demand for data on atomic spectra derived from the analyses of optical spectra has prompted the planning of several sections of a publication, to be known as NSRDS–NBS 3. Two innovations have been introduced in this publication. In order to supply much needed data to workers in such developing fields as space technology, plasma physics, and astrophysics, as quickly as possible, sections of NSRDS–NBS 3 will be published at different intervals, whenever adequate data for the individual spectra are available. Besides the spectra, both the atomic energy levels and the multiplet table for each spectrum will be included in each issue.

This first section, by Charlotte Moore, is entitled Atomic Energy Levels and Multiplet Tables, Si II, Si III, Si IV.

Examination of Liquefied Petroleum Gas Liquid-Measuring Devices

Specialization in weights and measures administrative procedures has indicated a need for handbooks on individual subjects to replace a single handbook covering the general area of testing measuring equipment. Handbook 99, published in "pocket size" for convenient use in field testing, is the latest product of this specialized series.

This publication by Malcolm W. Jensen details the volumetric method of testing LP Gas liquid-measuring devices. This method is more accurate and more nearly approximates the actual operation of the measuring device than does the gravimetric method. Descriptions of apparatus, methods of calibration, step-by-step procedures for inspecting and testing commercial devices are given, and a report form plus procedure for completing it are suggested. Safety precautions are included as a "Hazardous Substance Warning" and as particular procedures to be followed during certain steps in the test.

Systems Engineering in Ceramics

Miscellaneous Publication 267, edited by H. F. McMurdie, covers the proceedings of the American Ceramic Society Symposium held in Chicago, Ill., in April 1964. It provides a general introduction to the field, discusses the relationship of systems engineering to other fields in engineering design and the basic concepts used in confronting a systems problem. Other matters discussed are process control systems, and two important systems engineering techniques, those of computer and statistical methods. The final paper draws those preceding it together with examples of systems of interest to ceramic engineers. Although the material in some chapters pertains mostly to ceramics problems, there is a wealth of information on the whole field of systems engineering.

The Statistical Analysis of Experimental Data

The Statistical Analysis of Experimental Data,[1] by John Mandel, Consultant on Mathematical Statistics of the NBS Institute for Materials Research, is written for the physical scientist who wants to utilize current statistical methods in his work, rather than for the theoretical statistician. In keeping with this aim, the book contains a great many worked examples, nearly all of which are taken from actual problems and the laboratory data specific to them. Another distinguishing feature is the consideration, in the last 80 pages of the book, of a class of problems increasingly common in large-scale research activities and in science-oriented industries seeking to establish general agreement on reliable test procedures. These chapters deal with what has been called "the measurement of measurement," the use of statistical criteria for evaluating test and measurement procedures.

However, most of the book is concerned with more conventional topics, which are presented with a minimum of mathematics. The following are principal subjects: basic working concepts (among others: probability distribution functions, population and sample, normal distribution, combination of random variables, central limit therorem, and propagation of errors); homogeneous sets of measurements; precision and accuracy; method of least squares; testing the statistical model; analysis of structured data; some principles of sampling; and fitting of straight lines, curves and surfaces.

Special Issue of *Radio Science*

The December issue of *Radio Science* (NBS Journal of Research, Sec. D) will be devoted to papers on planetary atmospheres and surfaces. *Radio Science* is cosponsored by the Bureau and the International Scientific Radio Union (URSI). The editors are James R. Wait of ESSA's Institute for Telecommunication Sciences and Aeronomy (formerly CRPL) and, for URSI, Professor L. A. Manning of Stanford University. Serving as guest editor for this issue is Dr. W. E. Gordon of Cornell University. With the transfer of CRPL to ESSA (see story on p. 178), starting with the January issue ESSA will replace the Bureau as cosponsor of *Radio Science*.

The special issue reports on the Symposium on Planetary Atmospheres and Surfaces, which was held at Dorado, Puerto Rico, May 24 to 27 under the sponsorship of the International Scientific Radio Union (URSI) and the International Astronomical Union. The Symposium consisted of six sessions at which invited papers and shorter contributed papers were presented and discussed. This issue of *Radio Science* will present the invited papers in full, all of the contributed papers in full or in summary, and the discussions as summarized from notes of the session chairmen.

The Symposium highlighted several controversies, notably those concerning the rotational period of the planet Mercury, the dielectric constant of the lunar surface layer, and the validity and meaning of radar echoes reportedly obtained from Jupiter. A lively discussion among the participants was generated on each of these topics.

Another highlight of the Symposium was the discussion of radar mapping of surface features of the planets Venus and Mars, the latter having an apparent relation with optical features, and of the craters of the Moon with a resolution equal to that of the unaided eye.

Several of the observations reported were related in the broad sense to the weather and its changes on the planets.

[1] The statistical analysis of experimental data, *by John Mandel, $12.00, John Wiley & Sons, New York, 1964.*

Polarization Measurement in the Vacuum Ultraviolet

■ A simple, direct method for measuring the degree of plane polarization in the vacuum ultraviolet has been devised by K. Rabinovitch, L. R. Canfield, and R. P. Madden of the NBS Institute for Basic Standards.[1] With this method, measurements can be made quickly and with only a modest amount of equipment. This work was supported in part by the U.S. Atomic Energy Commission.

The technique may be used for measuring the behavior of ultraviolet light passing through optical instruments. A variety of such instruments are used in rockets and satellites to study ultraviolet light in the upper atmosphere and similar instruments are used in plasma physics. This technique should be valuable in understanding and evaluating the data gathered by these instruments.

Polarization can be easily measured by conventional techniques from the visible region to the quartz ultraviolet where polarizing materials are available. However, for wavelengths shorter than 1200 Å, no effective polarizer has been developed.

In many experiments involving emitted radiation the degree of polarization (if any) is one of the characteristics which must be determined. For example, monochromators generally have a polarizing effect on the radiation they disperse. This can be caused by the use of reflecting or transmitting optics at other than normal incidence, by gratings, or by narrow slits. The amount of such polarization will vary with the instrument design and can be expected to show a spectral dependence. For many applications it is desirable to know the degree of plane polarization which exists in the emerging radiation.

The method presented here can be used to determine the degree of plane polarization of radiation emergent from a monochromator. Two variations of the method have been devised, both of which utilize a special condition on the polarization of a reflector which holds when the angle of incidence of the emergent beam is 45°. The determination by either variation relies on Maxwell's equations and requires only a measurement of the reflectance at 45° angle of incidence with two or three orientations of the reflector about the optical axis.

The first procedure is particularly simple but requires that the partial plane polarization maximum lie along one of two orthogonal known axes—e.g., parallel with, or perpendicular to, the exit slit of a monochromator. The other procedure requires an additional measurement, but assumes only that the monochromator light source is incoherent. In either method a detailed knowledge of the optical constants of the reflector material is not required.

The plane polarization of a ½-meter Seya-Namioka vacuum ultraviolet monochromator was measured by the new methods using two different gratings with two different surface coatings on one of the gratings. This was done in order to determine the degree to which the polarization depended on the grating. It was shown that plane polarization of the monochromator in the far ultraviolet strongly depended on the individual grating used and on the overcoating material as well.

Because of this dependence, the degree of plane polarization which was determined for the monochromator used in this experiment may or may not be typical of this type of instrument. However, it is obvious that one must expect strong polarization effects in this design of monochromator. It would be of considerable interest to use these methods to explore the polarization characteristics of a number of other monochromator designs, and to achieve a better understanding of the polarization caused by gratings in the far ultraviolet spectral region.

Although the degree of plane polarization has been determined only for the exit beam of a monochromator, the methods can be applied to certain other situations as well. It is felt that in most cases the first, and simpler, method would be sufficient. This was verified with the ½-meter Seya-Namioka monochromator used in this experiment. However, the second method is available for cases where the electric vector maximum of the partially plane polarized radiation is neither parallel nor perpendicular to the exit slit.

[1] *For further technical details, see* A method for measuring polarization in the vacuum ultraviolet, *by K. Rabinovitch, L. R. Canfield, and R. P. Madden, J. Appl. Opt. (in press).*

Publications of the National Bureau of Standards

Periodicals

Technical News Bulletin, Volume **49**, No. 10, October 1965. 15 cents. Annual subscription: $1.50, 75 cents additional for foreign mailing. Available on a 1-, 2-, or 3-year subscription basis.

Journal of Research of the National Bureau of Standards

Section A. Physics and Chemistry. Issued six times a year. Annual subscription: Domestic, $4; foreign, $4.75. Single copy, 70 cents.

Section B. Mathematics and Mathematical Physics. Issued quarterly. Annual subscription: Domestic, $2.25; foreign, $2.75. Single copy, 75 cents.

Section C. Engineering and Instrumentation. Issued quarterly. Annual subscription: Domestic, $2.25; foreign, $2.75. Single copy, 75 cents.

Section D. Radio Science. Issued monthly. Annual subscription: Domestic, $9; foreign, $11.50. Single copy, $1.00.

Current Issues of the Journal of Research

J. Res. NBS **69A** *(Phys. and Chem.), No. 6 (Nov.–Dec. 1965).*

Arc measurement of some argon transition probabilities. C. H. Popenoe and J. B. Shumaker, Jr.

Theoretical interpretation of the third spectrum of gold (Au III). Y. Shadmi.

Photopolarographic behavior of inorganic depolarizers. R. A. Durst and J. K. Taylor.

Spectral structure of critical opalescence: binary mixture. R. D. Mountain.

Irregularities in the NBS (1955) provisional temperature scale. H. M. Roder.

Isotherms determined by the National Bureau of Standards acoustical thermometer in the liquid helium temperature range. G. Cataland and H. Plumb.

Synthesis of D-glucose-3-^{14}C and related compounds. H. L. Frush, L. T. Sniegoski, N. B. Holt, and H. S. Isbell.

Correlation of large longitudinal deformations with different strain histories. L. J. Zapas and T. Craft.

Crystallography of tetracalcium phosphate. W. E. Brown and E. F. Epstein.

Electrode potentials in fused systems X. Measurement of cation concentration in molten salts using glass membrane electrodes. K. H. Stern and S. E. Meador.

Radio Sci. J. Res. NBS/URSI **69D**, *No. 11 (November 1965).*

Propagation of pulses in dispersive media. J. R. Wait.

An anisotropic electron velocity distribution for the cyclotron absorption of whistlers and VLF emissions. H. Guthart.

Nose whistler dispersion as a measure of magnetosphere electron temperature. H. Guthart.

Interference rejection capability of a switched radiometer. R. E. Clapp.

Atmospheric breakdown limitations to optical maser propagation. R. G. Tomlinson.

Phase steps and amplitude fading of VLF signals at dawn and dusk. D. Walker.

Propagation in a model terrestrial waveguide of nonuniform height theory and experiment. E. Bahar and J. R. Wait.

Comments on H. Volland's Remarks on Austin's Formula." J. R. Wait.

The path integrals of LF/VLF wave hop theory. L. A. Berry and M. E. Chrisman.

Reactive loading of arbitrarily illuminated cylinders to minimize microwave backscatter. K. M. Chen.

On the statistical theory of electromagnetic waves in a fluctuating medium (II) Mathematical basis of the analogies to quantum field theory (a digest). K. Furutsu.

Other NBS Publications

Hydraulic research in the United States 1965, Ed. H. K. Middleton, NBS Misc. Publ. 270 (July 22, 1965), $1.25.

Quarterly radio noise data March, April, May, 1964, W. Q. Crichlow, R. T. Disney, and M. A. Jenkins, NBS Tech. Note 18–22 (Aug. 2, 1965), 50 cents.

Accuracy in measurements and calibrations, 1965, W. A. Wildhack, R. C. Powell, and H. L. Mason, NBS Tech. Note 262 (June 15, 1965), $1.00.

Electrochemical analysis: Studies of acids, bases, and salts by EMF conductance, optical and kinetic methods July 1964 to June 1965, Ed. R. G. Bates, NBS Tech. Note 271 (Sept. 6, 1965), 60 cents.

Analysis and purification section: Summary of activities July 1964 to June 1965, Ed. J. K. Taylor, NBS Tech. Note 273 (Oct. 1, 1965), 50 cents.

A numerical representation of CCIR report 322 high frequency (3–30 MC/S) atmospheric radio noise data, K. L. Lucas and J. D. Harper, Jr., NBS Tech. Note 318 (Aug. 5, 1965), 55 cents.

Publications in Other Journals

This column lists all publications by the NBS staff, as soon after issuance as practical. For completeness, earlier references not previously reported may be included from time to time.

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